CHAPTER 12

DOMESTIC WATER SYSTEMS

12-1. Domestic water system description

Domestic water (potable water) is water that is free from any significant impurities that would cause disease or harmful physiological effects to humans, and is in compliance with the water quality requirements of the Health Service having jurisdiction.

a. System functions. The purpose of the domestic water system is to provide the occupants of a facility an adequate quantity of domestic water for drinking and for the proper operation of plumbing fixtures utilized for personal health and hygiene. The domestic water system must also protect the water it conveys from harmful substances that would damage the water quality and make it unfit for human consumption. The domestic water system is comprised of a water supply; a water distribution system; auxiliary components such as water heaters, pumps, storage equipment, and backflow prevention devices; and the termination point of use that are the plumbing fixtures.

b. Water supply. The water supply may be from a public or private onsite system. Public systems are generally very reliable, however, for critical facilities, the use of a private system in conjunction with a storage system or a private onsite water supply will ensure the availability of water at all times.

(1) An example of a typical domestic water system with reservoir storage (under normal operation) is shown on figure 12-1. In this arrangement, under normal conditions, the plumbing fixtures are supplied with water directly from the public water supply. The public water supply is metered and then distributed throughout the facility. The supply of water to equipment and uses that may contaminate the domestic system is provided through a backflow preventer. The water downstream of the backflow preventer is referred to as nonpotable, and is not for human consumption.

(2) During periods when the public water system is out of service, water is drawn from the reservoir and supplied to the facility through the use of the reservoir pump (emergency operation). The pump is controlled by a pressure switch, and system pressure is maintained by the hydropneumatic tank as the pump cycles. Check valves in the system prevent water flow back into the public system when the reservoir pump is operating and prevent backflow through the pump when it is not operating. The reservoir is kept filled with water when operating from the public system; however, the reservoir water must be pumped out and refilled on a regular basis to prevent stagnation and contamination of the stored water.

12-2. Domestic water system major components

Domestic water systems are generally comprised of the following major components.

a. Water storage. Water storage systems may be associated with a private water system in which case the storage would act as a buffer to maintain a relatively constant supply pressure. Water storage systems also may function as an emergency backup supply in the event that the public water supply is taken out of service. The principle types of water storage are tanks, reservoirs, and bladder tanks. All storage structures utilized for domestic water must be constructed of nontoxic materials that resist corrosion, and must be disinfected prior to use.

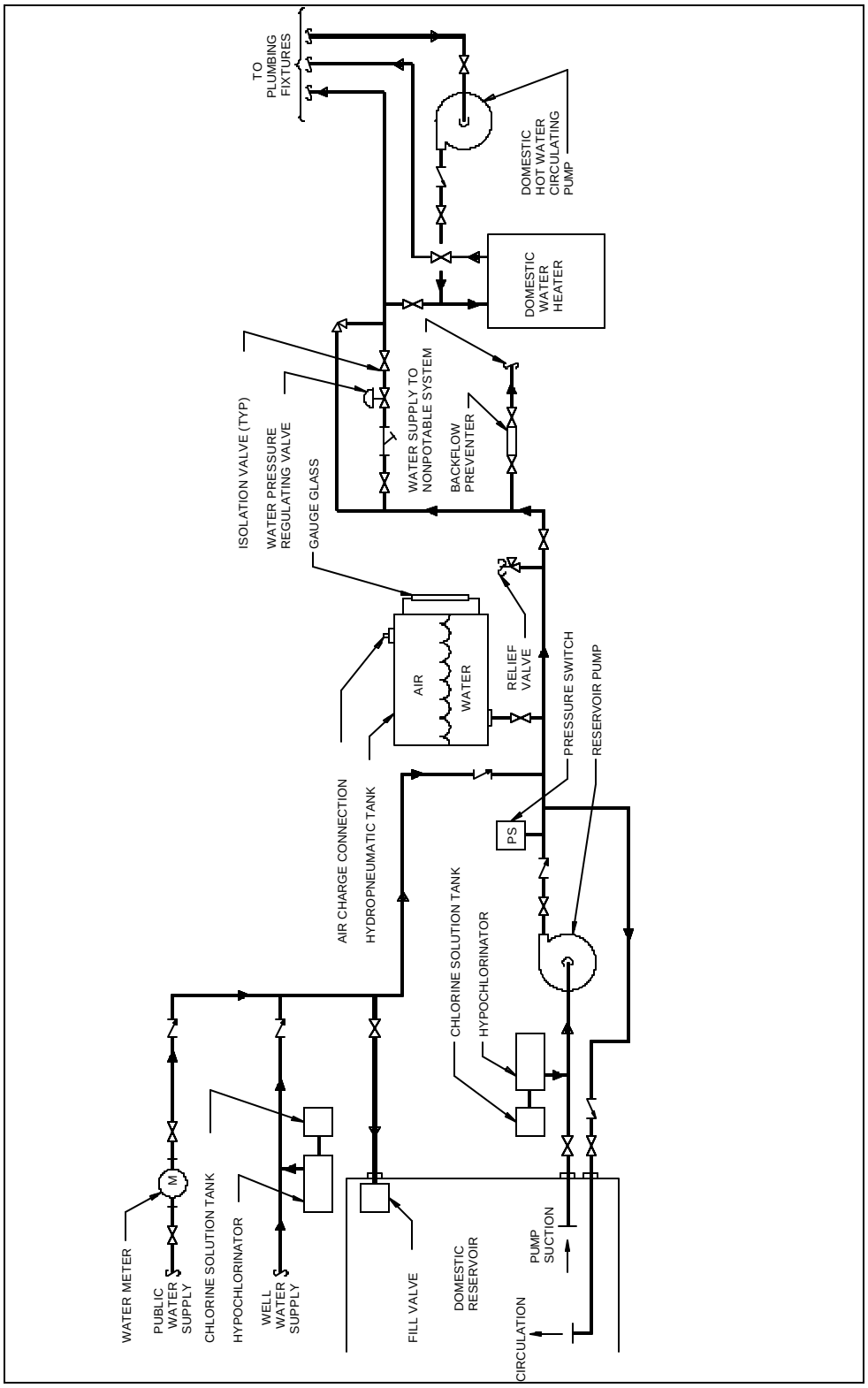

Figure 12-1. Domestic water system with reservoir storage

(1) The discussion will focus on two types of aboveground tanks: ground-mounted and elevated. The elevated storage tank is used in flat-land areas where the terrain does not offer the advantage of a high point near the water use point in which a ground-mounted tank could be located. The elevated storage tank consists of a tank (usually steel), structural support legs, and water standpipe. The ground-mounted tanks are also usually constructed of steel, and are typically mounted on a concrete foundation. The pump and piping arrangement serving the storage tanks is dependent on the tank elevation. If the tank is well above the water use point (60 to 100 feet), the water supply is pumped into the tank to maintain a certain water level, and the tank is not pressurized. The water pressure at the use point is equivalent to the water elevation in the tank (100 feet = 43 psig). If the water storage tank is at or near the same elevation of the use point, the tank is usually pressurized if it is used as a constant water supply system. If the tank is used for emergency purposes only, it may have pumps on the discharge and then would not be pressurized.

(2) Reservoirs are typically underground concrete water storage structures. Typically the reservoir is not pressurized and is fed from a private or public water system, or in some cases may be spring fed. It is common for pumps to draw from the reservoir and pump into the pressurized water system at a facility. Reservoirs typically have an access for maintenance personnel and a vent to prevent pressure buildup.

(3) Bladder tanks, also referred to as hydropneumatic tanks, consist of a steel tank that is divided into an air section and a water section by a rubber bladder. The air section is charged with air to a pressure equivalent to the minimum desired pressure in the water supply system. A bladder tank is commonly installed on a private water supply system to provide some storage capacity and to act as a buffer for the supply pumps (figure 12-2). Typically, one third of the total tank capacity is available for storage (a 200 gallon tank would result in 70 gallons of useful storage).

b. Water heaters. The purpose of the domestic water heater is to provide hot water at the desired temperature to the plumbing fixtures and to any other point of use. System water temperatures range from 120 to 140^{o}F for typical plumbing fixtures, up to 165^{o}F for laundry, and 180 to 190^{o}F for dishwashing and sanitizing applications (see figures 12-3, 12-4, and 12-5).

(1) Heat energy sources include oil, propane and natural gas, electricity, and steam. Oil and gas units are generally referred to as fuel type direct-fired water heaters. Electric water heaters employ a direct conversion of electrical energy into heat. Indirect water heating is accomplished through the use of remote heat sources (usually boilers) which supply steam to the water heater. The water heater then uses steam as an energy source to heat the domestic water.

(2) Water heaters are also classified as to their storage capacity and recovery rate. The recovery rate is the amount of water in gallons per hour (gph) that can be raised +100◦ F at a given heat input. The storage capacity allows large volumes of hot water to be drawn from the system at flow rates that exceed the recovery capacity of the heater. Instantaneous heaters have a high recovery rate and very little storage, while storage type heaters have a lower recovery rate and significant storage capacity. A semi-instantaneous heater is a variation of the above two types, with limited storage and moderate recovery rates.

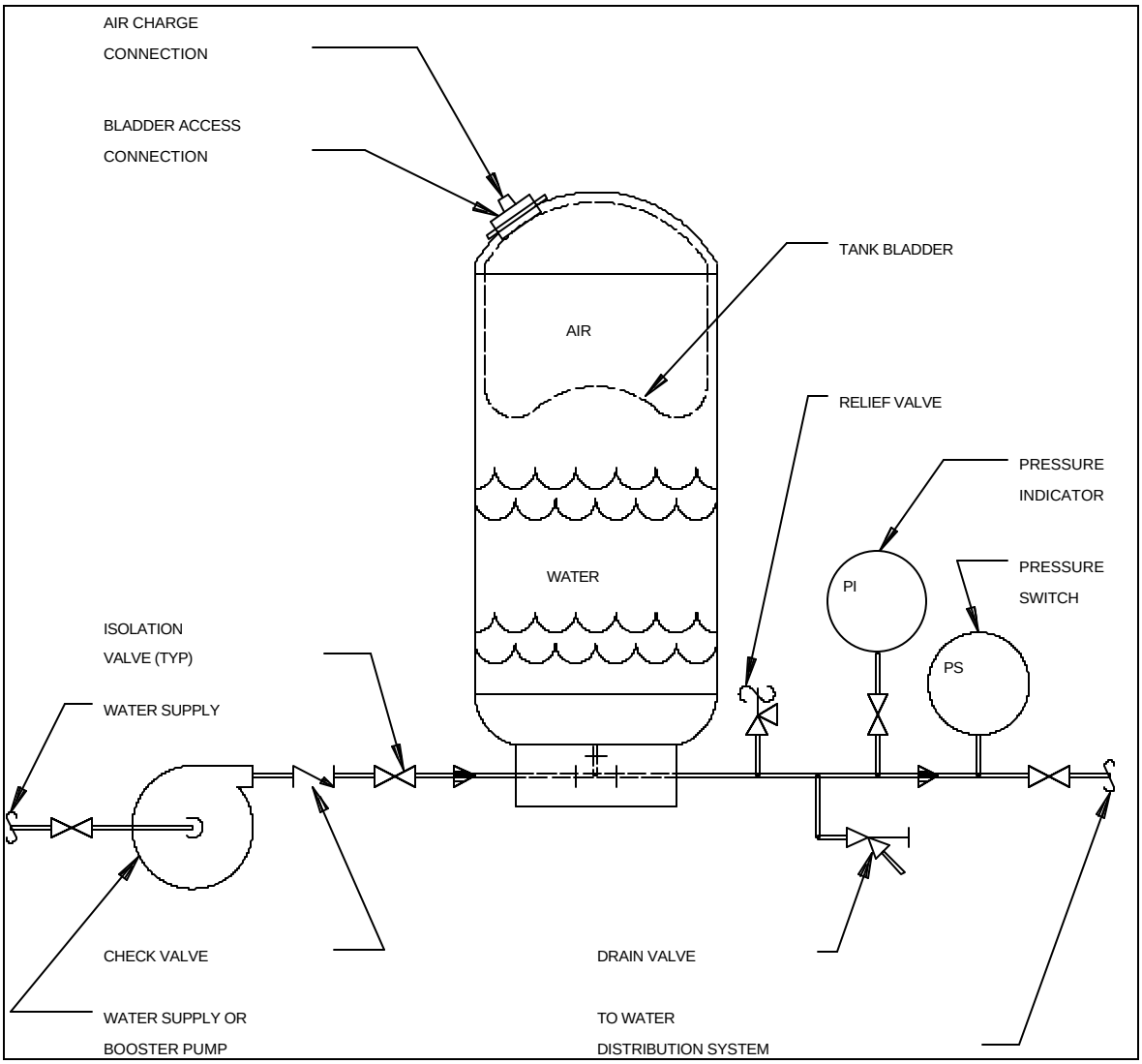

Figure 12-2. Bladder tank installation

c. Plumbing fixtures. The plumbing fixture is the termination point of the domestic water system and is the beginning of the sewer system. Since the quantity of water consumed by the plumbing fixture presents a load on both the domestic water supply system and the sewage disposal/treatment system, all plumbing fixtures should be maintained to minimize water usage. All plumbing fixtures should be provided with shutoff valves on the water supply to allow for servicing. The most common plumbing fixtures are water closets, urinals, lavatories, service sinks, general purpose sinks, and drinking fountains.

d. Backflow preventers. Backflow preventers are devices used to prevent the contamination of the domestic (potable) water system. Backflow preventers can be classified into four basic types, with the proper application of each type dependent upon the piping arrangement and the degree of hazard involved. The basic types of backflow preventers are illustrated on figure 12-6.

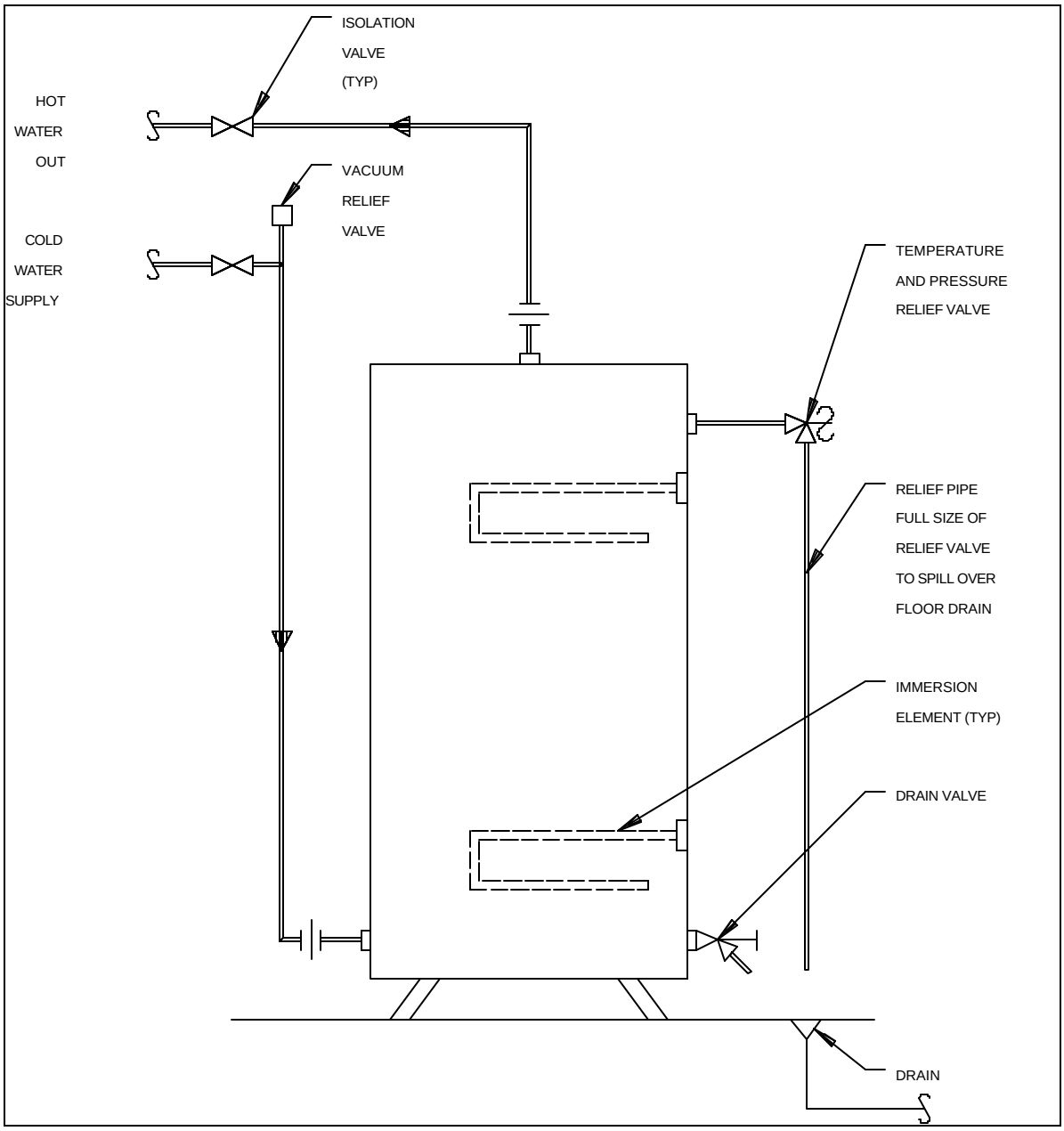

Figure 12-3. Electric water heater

e. Valves and piping. A variety of valves and piping materials are commonly used in domestic water systems.

(1) Valves installed in the domestic water system are to control water flow and to isolate equipment for ease of operation and maintenance. Most valves in a domestic water system are manually operated with a handwheel or lever operator.

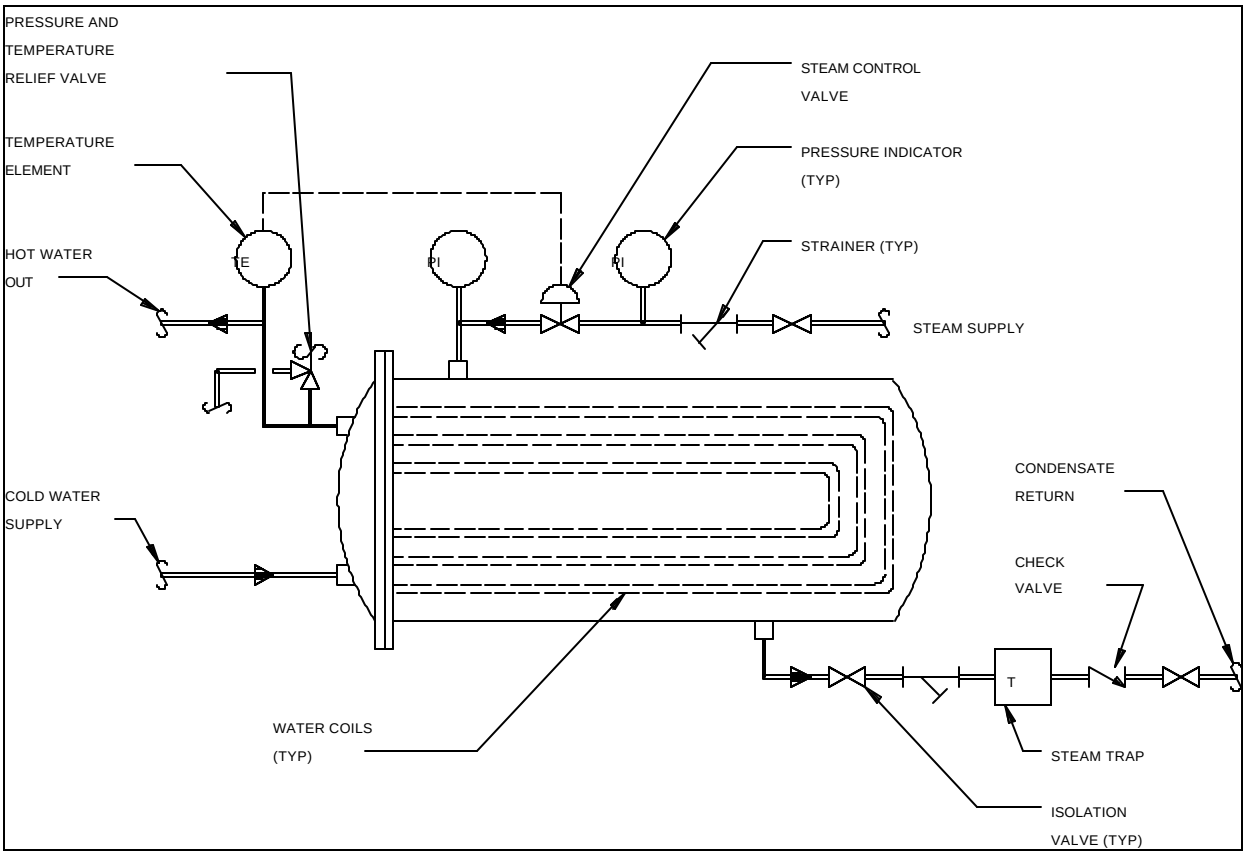

Figure 12-4. Instantaneous steam water heater

(2) Piping materials that convey domestic water must be specifically approved for this use. Typical code-approved piping materials for water distribution include brass pipe, copper tube or copper pipe, galvanized steel pipe, ductile iron pipe, and approved plastic pipe. Pipe and fittings for use in domestic water systems shall not contain more than 8 percent lead. Solder used for joining copper tubing shall not contain more than 0.2 percent lead.

(a) Piping systems should be inspected and tested prior to being concealed and put in service. Minimum test pressure should be 80 psig or the working pressure, whichever is greater. A visual inspection should be made to identify proper installation, including joints and connections, supports, access to valves, and cross connections. Pipelines should be identified as to the fluid contained by color coding or identification tags. An adequate quantity of unions or flanges should be provided at all pieces of equipment to allow for servicing of the equipment. Drain valves should be installed at low points of the piping system to facilitate draining of the system for maintenance. Installation of pipe over electrical equipment should be avoided or should be provided with drip pans.

(b) Brass pipe is an alloy of copper and zinc and is found on a limited basis in domestic water systems. The most common use is for gauge piping and for piping of equipment accessories. Available sizes range from 1/8 inch up to 12 inch. Smaller diameter fittings are usually screwed whereas larger diameter fittings are flanged type.

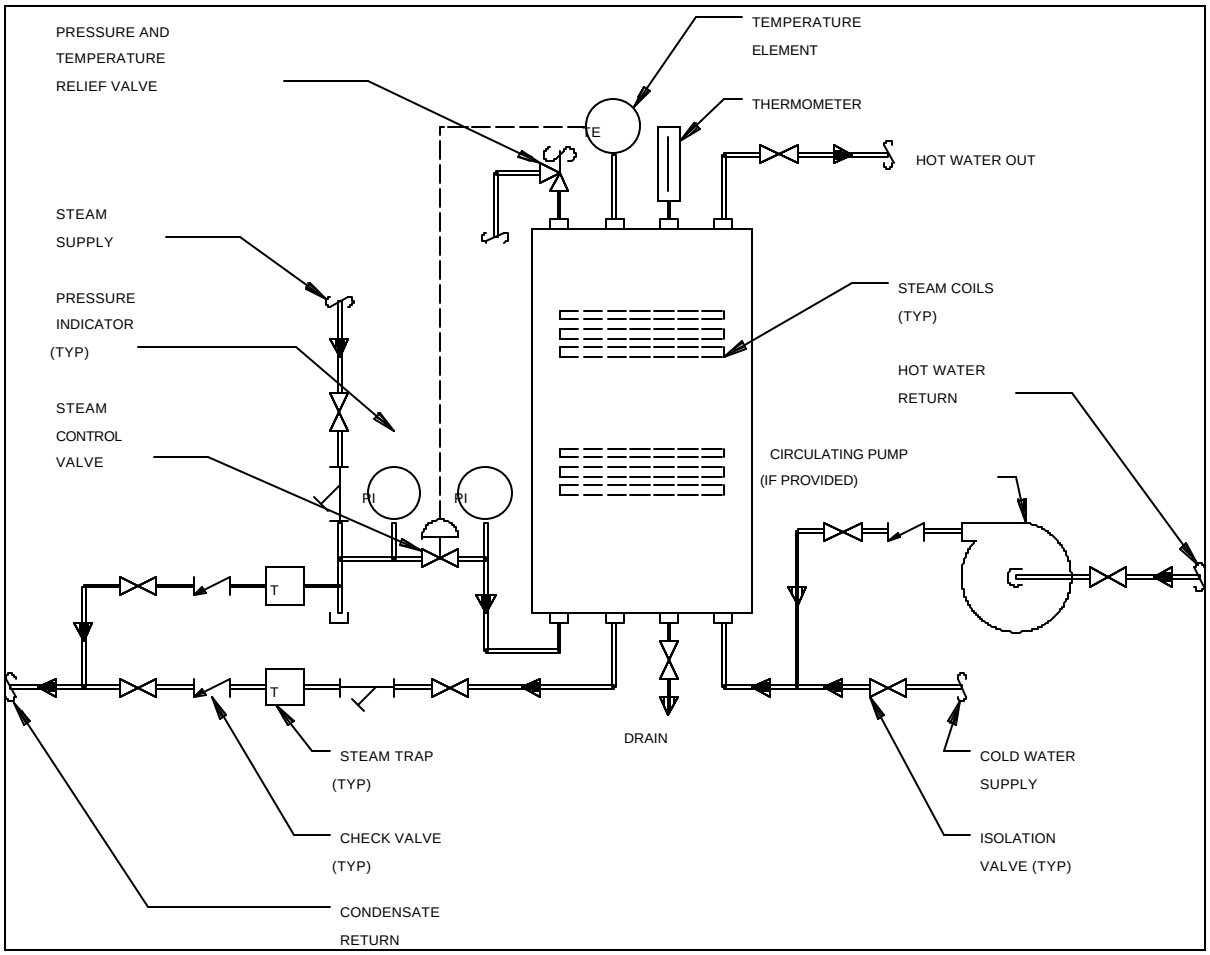

Figure 12-5. Semi-instantaneous steam water heater

(c) Copper pipe and tubing is common in domestic water service and distribution systems. Copper pipe is used on a limited basis for applications similar to that of brass pipe. Copper tubing, however, is used extensively for water service and distribution, especially in pipe sizes 3 inch and smaller. Copper water tube is designated as Type K, L, or M, and is available in drawn (hard) or annealed (soft) tempers in sizes from 1/8 to 12 inch. Copper tubing is also color-coded with a stripe to designate Type K (green), Type L (blue), or Type M (red). Type K tube is the heaviest of the three types and is used primarily for underground water services. Type L tube is used widely for underground water services and for interior water distribution piping. Type M tube is the lightest weight of the three tube types. Type M tube is approved for interior water distribution, however, it is preferable to use the heavier Type L tube for this application.

(d) Galvanized steel pipe is available in three basic weight categories including standard weight, extra-strong, and double extra-strong. American Society for Testing and Materials (ASTM) A 53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless, Grade B, standard weight (Schedule 40) galvanized steel pipe is the most common type of steel pipe used for domestic water application. Fittings are generally malleable-iron and threaded. Galvanized steel domestic water systems require more maintenance than non-ferrous systems due to the deterioration of the zinc-coating (galvanizing) and the natural oxidation of the steel over the lifetime of the system.

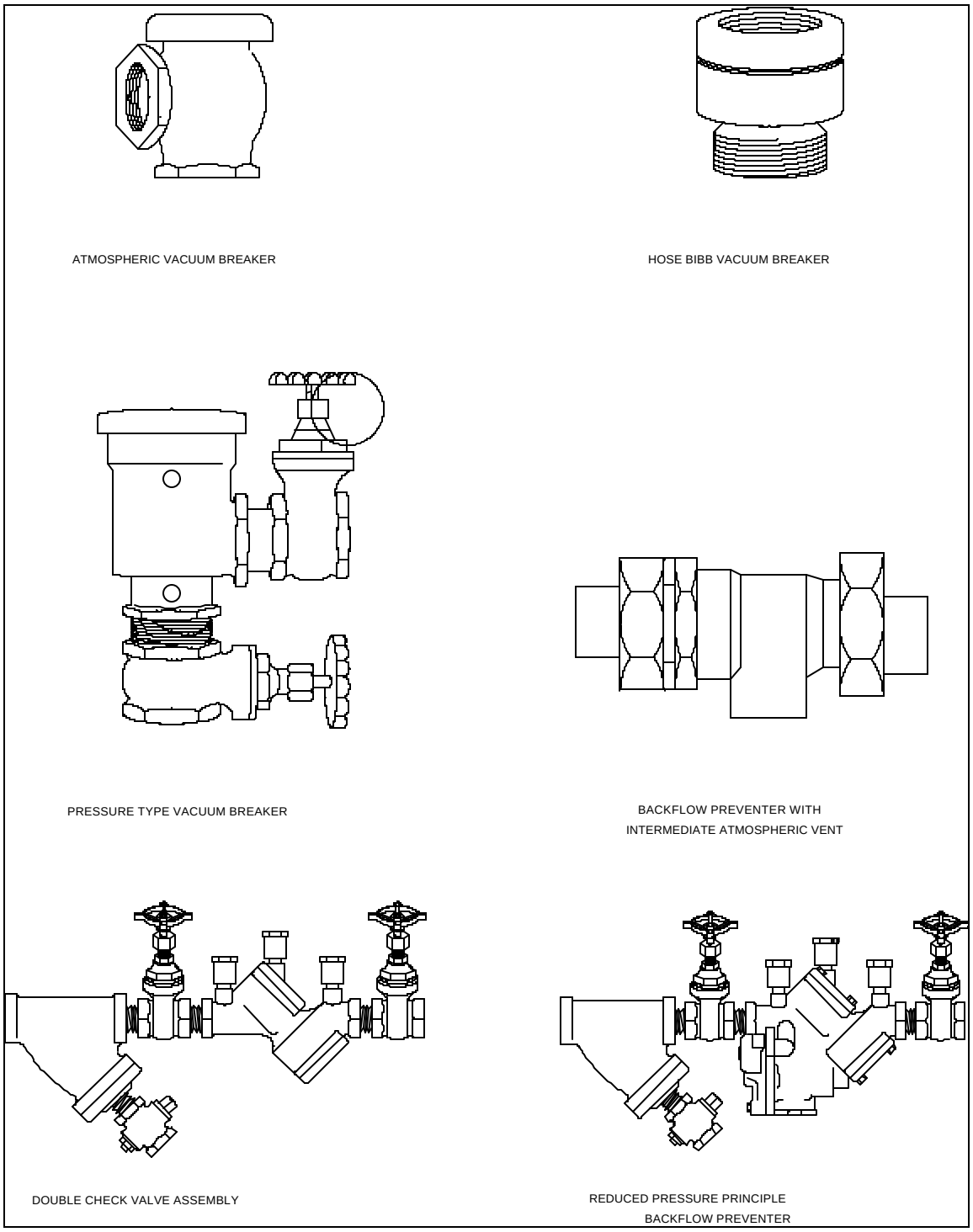

Figure 12-6. Backflow preventers

(e) Ductile iron pipe is typically used for underground water services and for water distribution in pipe sizes of 4 inch and larger. Fittings are generally push-joint for underground applications and flanged or mechanical joint for aboveground applications. Ductile iron pipe and fittings for domestic water systems must be cement mortar lined per the requirements of the American Water Works Association (AWWA) C104, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water (1995).

(f) Plastic pipe is available in various types, some of which are approved for domestic water services and others which are approved for domestic water distribution. Generally polybutylene (PB), polyvinyl chloride (PVC), and polyethylene (PE) are approved for underground water services, whereas interior water distribution systems are limited to chlorinated polyvinyl chloride (CPVC) and PB pipe and tubing. PVC and CPVC fittings are available in solvent weld, threaded, and flanged types. PB and PE fittings are available in thermal fusion and compression types. Metal insert fittings are also available for PB pipe. Plastic pipe has excellent characteristics for resistance to corrosion, therefore, it is well-suited for corrosive atmospheres or for use in soils where corrosion protection would be required for metallic piping systems. An interior plastic water distribution system will require considerably more pipe supports than a metallic system due to the poorer strength characteristics of plastic. Also, the combustion qualities of plastic pipe prevent its use in some building areas, including spaces used as air plenums.

f. Pumps. Pumps are most commonly used in domestic water systems for boosting water pressure and for hot water circulation. There are two basic types of pumps: positive displacement and centrifugal.

g. Water treatment equipment. Water treatment equipment generally associated with domestic water systems includes hypochlorinators and water softeners. Hypochlorinators are used to disinfect well water and water reservoirs, whereas water softeners are used to remove dissolved solids from the water supply.